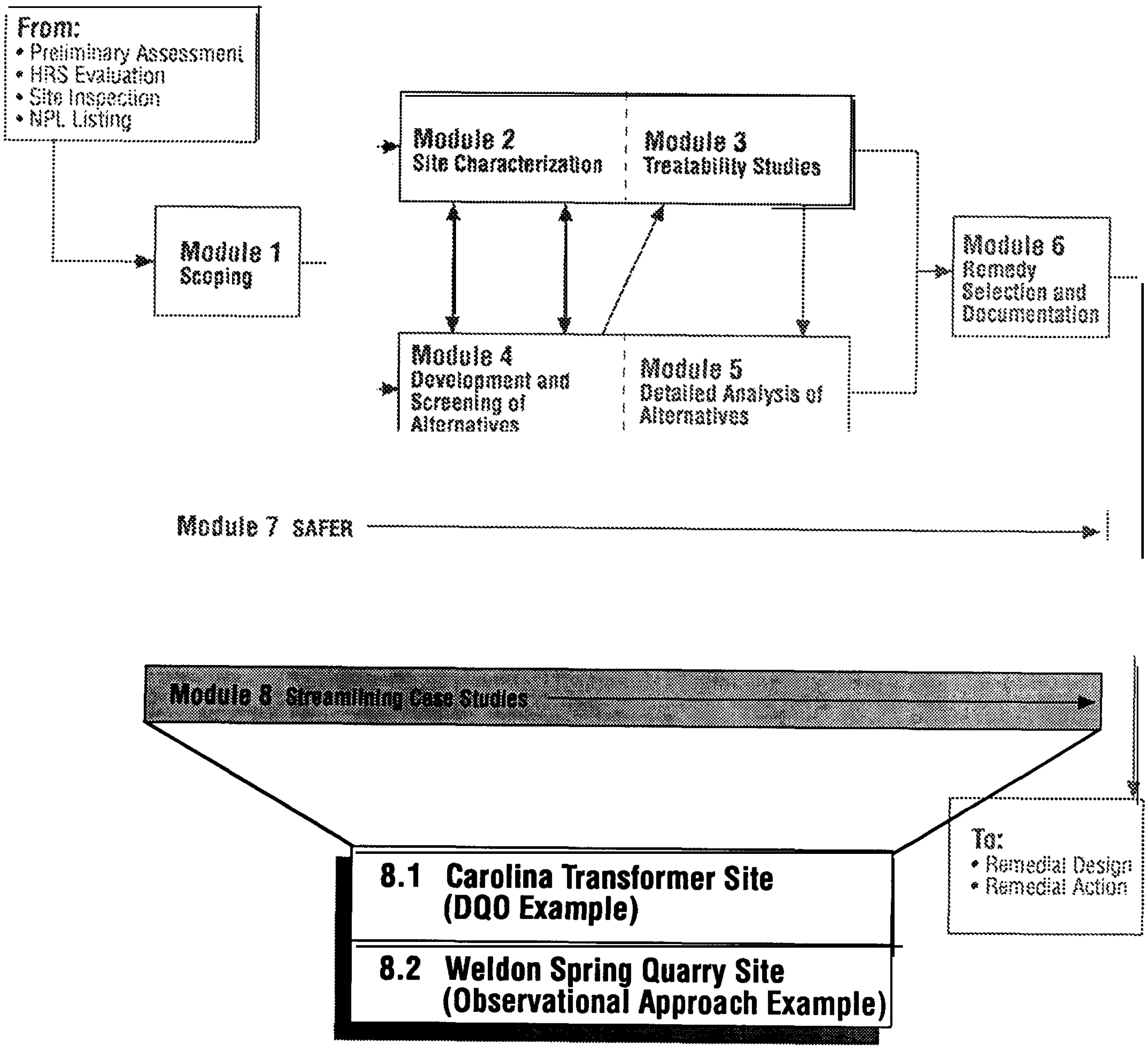
# Module 8
# Streamlining Case Studies

**Contents**

# Module 8. Streamlining Case Studies



# Module 8
# Streamlining Case Studies

***Background***

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) strongly emphasizes the pursuit of a "bias for action" and streamlining throughout the remedial process. Based on the Environmental Protection Agency (EPA) expectations documented in the NCP and experience in the Superfund program, the Department of Energy (DOE) also has identified a strong need for streamlining. From this recognition, DOE has developed SAFER (see Module 7). SAFER is based on two primary streamlining methodologies: the data quality objectives (DQOs) process as formulated by EPA's Quality Assurance Management Staff (QAMS), and the observational approach. SAFER's development is recent enough so that sufficient time has not transpired to allow application through an entire Remedial Investigation/Feasibility Study (RI/FS). However, several documented applications of the DQO process and observational approach do exist. One application of each has been selected as examples for Module 8. The goal of streamlining is to expedite cleanup while still achieving proper protection of public health and the environment. The two case studies summarize activities and strategies undertaken to achieve streamlining.

The first case study focuses on application of the DQO process at the Carolina Transformer site (EPA fund-lead site). The second case study highlights application of the observational approach at DOE's Weldon Spring Quarry. These case studies also provide insight into the strategy that is crucial to the effective implementation of any streamlining method.

This module is intended to be used in conjunction with the RI/FS modules (Modules 1 through 5), Remedy Selection and Documentation (Module 6), and SAFER (Module 7). The two case studies should be used for understanding how streamlining techniques are tailored to maximize the utility of site-specific conditions. The concepts presented in these case studies (e.g., emphasis on planning, focus on problem) are broadly applicable to any site and consistent with the emphasis of this guidance document. Specific details used at each site (e.g., pilot study at the Carolina Transformer site and RI based on manifest data at Weldon Spring Quarry) were appropriate for their applications, however may not be broadly applicable to other sites.

***Organization***

Module 8 is divided into two submodules

8.1 Carolina Transformer (DQO Example)
8.2 Weldon Spring Quarry (Observational Approach Example)

# Submodule 8.1 Carolina Transformer Site (DQO Example)

**Streamlining Case Studies**

- **8.1 Carolina Transformer Site (DQO Example)**
- 8.2 Weldon Spring Quarry Site (Observational Approach Example)

**8.1 Carolina Transformer Site (DQO Example)**

- Stage 1-Identify Decision Types
- Stage 2-Identify Data Uses and Needs
- Stage 3-Design Data Collection Program

## Submodule 8.1 Carolina Transformer Site (DQO Example)

### *Background*

Data often are collected at a site without sufficient consideration for data use or for the decisions these data would have to facilitate and support. Site data often were and are still compiled by data collectors (e.g., field sampling teams) without consulting the data users (e.g., risk assessors). The DQO process is a series of steps that is used in developing data collection strategies and plans that avoid these difficulties and inadequacies experienced in the past.

In this example, the DQO process was used to determine the decisions that had to be made; to involve the decisionmakers in specifying data needs; to explore various sampling and analysis options for determining the resulting data reliability; and to set the final data collection strategy. This particular example relies heavily on the use of statistical techniques to evaluate data collection strategies. This does not imply that the DQO process is necessarily heavily dependent on statistics. In fact, the process involves addressing a logical sequence of steps that lead toward carefully targeted data collection efforts; the use of statistics is not inherent in the process (see Module 1.4). This case study provides an elegant example of the effectiveness of statistical arguments in developing sampling plans.

Although this case study is taken largely from Ryti and Neptune (1991) and Ryti (1991), the discussion here is structured differently to follow as closely as possible the DQO process steps as presented in *Data Quality Objectives for Remedial Response Activities* (EPA, 1987).

The major DQO process stages and steps are as follows:

- Stage 1. Identify decision types

  - Identify and involve data users
  - Evaluate available data
  - Develop conceptual model
  - Specify objectives and decisions

- Stage 2. Identify data uses and needs

  - Identify data uses
  - Identify data types
  - Identify data quality needs
  - Identify data quantity needs
  - Evaluate sampling and analysis options
  - Review precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters

- Stage 3. Design data collection program

  - Assemble data collection components
  - Develop data collection documentation

**[Note: EPA is expected in the near-term to release new DQO guidance. Once issued, DOE will provide updates to this case study, as appropriate.]**

The Carolina Transformer site is a former transformer storage and rehabilitation facility located on 4.8 acres of swampy terrain, lying within the 100-year floodplain of the Cape Fear River in North

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Carolina.  Rebuilding of transformers was discontinued in 1982, but storage of transformers continued until 1986 when the site was abandoned.  The initial sampling in 1978 detected polychlorinated biphenyls (PCBs) in both the soil and well water.  An emergency removal action was conducted by EPA in 1984 to remove contaminated soil, but sampling after the removal detected residual PCBs at up to 140 ppm in the subsoil.

The investigation efforts were comprised of two phases.  In Phase 1, the contaminants of concern and their general locations were determined.  EPA first assumed that the contamination would be detected in "hot spots" because of point releases of transformer oil at various locations around the site.  The most important result of the Phase 1 investigation was that 41 of the 45 samples were greater than 1 ppm PCBs action level.  Thus, from a risk perspective, nearly the entire site was considered a "hot spot."  The "hot spot" model, therefore, had to be discarded.  This case study focuses on the second phase of the investigation in which the primary purposes were to locate the soils above a 1 ppm action level and to estimate the volume of contaminated soil that would have to be excavated to achieve cleanup goals.  A previous phase of the investigation had established the general pattern of PCB contamination and established that PCBs were the only contaminants of concern.

In Phase 2, the locations of the PCBs and the volumes of the contaminated soils were to be determined more precisely in order to estimate the costs of various remedial alternatives.  Through the steps of the DQO process, EPA refined the general goal statements and developed quantitative DQOs (expressed as error tolerances in this example) for the data collection.  A highly targeted data collection effort was designed and completed during Phase 2.  Based on the results of that sampling effort, a detailed remediation plan was developed and accurate cost estimates were prepared.

***Organization***

Submodule 8.1 discusses the following:

- Stage 1–Identify Decision Types
- Stage 2–Identify Data Uses and Needs
- Stage 3–Design Data Collection Program

In addition, more detailed information is provided in the following notes:

- Submodule 8.1.1, Note A–Results of the DQO Process for the Carolina Transformer Site
- Submodule 8.1.3, Note B–Phase 2 RI Results

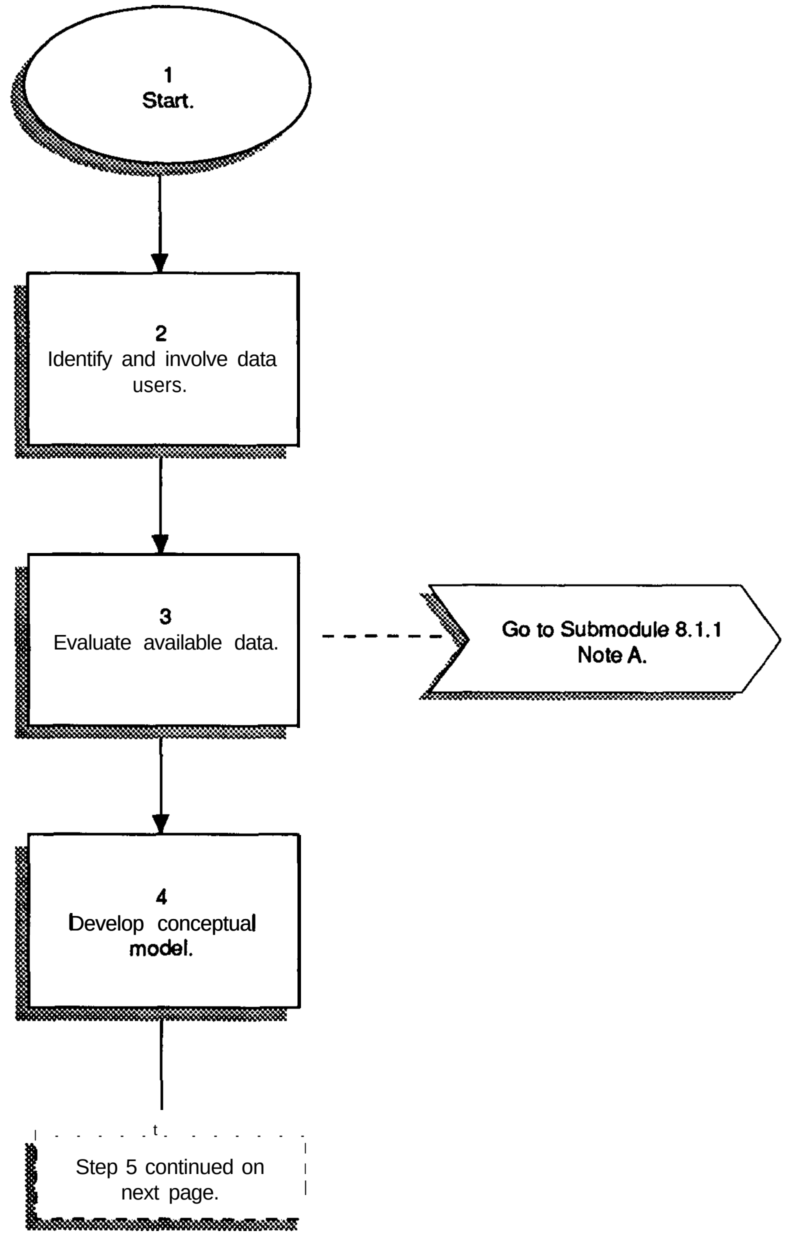
***Sources***

1. Ryti, Randall T. and Dean Neptune, November/December 1991, "Planning Issues for Superfund Site Remediation," *Hazardous Materials Control* 4:  47-53.

2. Ryti, Randall T., 1991, *Technical Appendix to "Planning Issues for Superfund Site Remediation*, Available from the author at Environmental Statistics Group, Montana State University, 406-994-3171.

3. U.S. EPA, March 1987, *Data Quality Objectives for Remedial Response Activities*, EPA/540/G-87/003, OSWER Directive 9335.0-7B.

# Submodule 8.1 .1 Stage 1- Identify Decision Types



**Step 1.** Start.

**Step 2.** **Identify and involve data users**. Because this was an EPA lead site, EPA would make the remediation decision, sign the ROD, and fund the cleanup. EPA was also the primary data user. Thus, EPA DQOs for the site characterization data were basic to every aspect of designing the investigation.

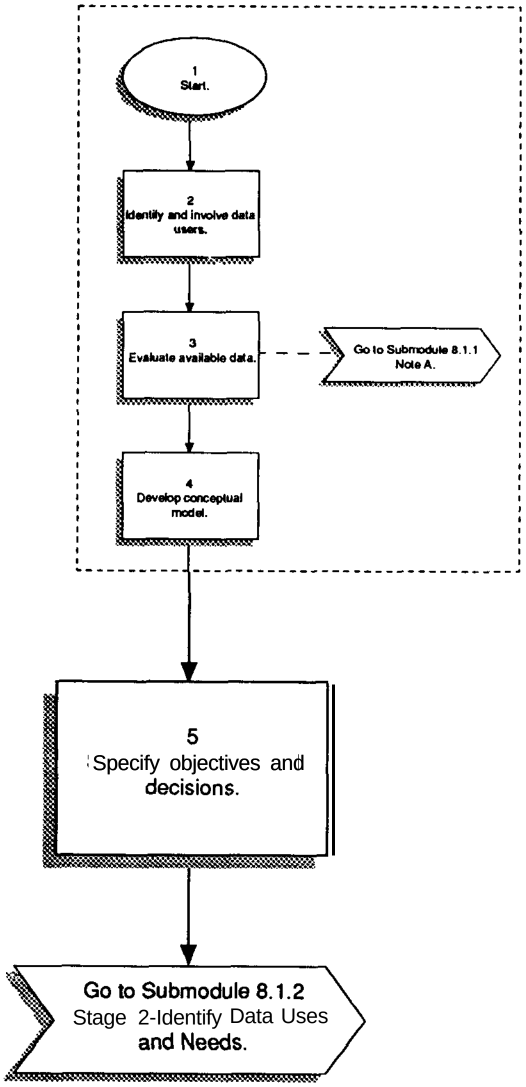
**Step 3.** **Evaluate available data**. In developing the Phase 2 investigation plan, the data from the Phase 1 investigation were the best available and were used to develop the conceptual model. In Phase 1, DQOs had been established, including EPA's willingness to tolerate certain levels of uncertainty (rates or probabilities of false positives and false negatives in detecting contaminated areas) in the data that would result. (The data from Phase 1 were to be used in the risk assessment and in the decision about whether remediation was required.) Phase 1 results are described in more detail in Submodule 8.1.1, Note A.

In order to increase the probability that the Phase 1 investigation data would meet the specified DQOs, a limited field investigation (LFI) was recommended and undertaken. Because the site was nearly completely contaminated with PCBs, the LFI results were more reliable than expected (despite the limited number of samples taken). Specifically, the LFI results met all of the DQOs established for Phase 1 with one exception: the potential error rate for false negatives was 7.5 percent rather than the 5 percent specified as acceptable. However, because so few of the areas tested clean (10 percent of the samples), the potential for obtaining false negatives was very low. EPA, therefore, determined that the difference in potential error rates (5 percent vs 7.5 percent) was negligible. Submodule 1.2, Site Understanding, provides guidance on evaluation of available data.

Although the data from Phase 1 were for general characterization of the site and for the risk assessment, they were not sufficient to establish accurate estimates of the volumes of soil that would have to be excavated to achieve various remediation goals, nor to facilitate design of the cleanup approach. EPA, therefore, decided to accept the pilot investigation and its results as Phase 1 of the investigation, base the risk assessment on this, and proceed to Phase 2 of the investigation.

**Step 4.** **Develop conceptual model**. Before the Phase 1 investigation, the conceptual model assumed a "hot spot" pattern for the contamination at the site. Specifically, it was assumed that activities at the site would have resulted in contamination at highly localized areas because of the draining or leaking of transformers at various locations. The model further assumed that the size of a hot spot would be approximately 10 feet × 10 feet or 100 square feet, with no spatial correlation between contaminated areas beyond 10 feet. Considering the volume of oil in a transformer, studies indicated that this was the likely area of contamination. The results of the Phase 1 investigation did not support this model, but showed widespread continuous contamination. A model assuming more general contamination had to be adopted. As a result of this change in conceptual model, the goal of the Phase 2 investigation changed from finding hot spots to identifying larger areas of the site (termed remediation units or RUs) that would have to be cleaned up. EPA examined various sizes of RUs, and the impact of various sizes on investigation and remediation costs were subsequently explored. Submodule 1.2, Site Understanding, provides guidance on developing conceptual models.

# Submodule 8.1 .1 Stage 1- Identify Decision Types (cont.)



The conceptual model also included exposure pathway assumptions regarding the receptors and exposure mechanisms that would likely occur in the future. Specifically, it was assumed that occupational exposures could occur if the site were used in the future as an industrial site. In addition, children trespassers (the most conservative risk estimate practical for this scenario) could be exposed to surface contamination over areas of approximately 1/2 acre (termed exposure units or EUs), the standard assumed area a child intruder might be expected to limit his or her activities to. One goal of the Phase 2 investigation (see Step 5 below) was to develop information that would identify which RUs would have to be excavated to ensure that each 1/2 acre EU did not present a risk to the public.

**Step 5.** **Specify objectives and decisions**. The risk calculations indicated that surface contamination at 1 ppm equated to a marginal risk of $10^{-6}$ for PCB exposures at the site. In addition, applicable or relevant and appropriate requirements (ARARs) that applied to the site specified that PCB contamination up to 10 ppm is acceptable at depths greater than 10 in.; thus, EPA added a preliminary remediation goal (PRG) that contamination up to 1 ppm is acceptable in the zero- to 10-in. layer and contamination up to 10 ppm is acceptable below 10 in.

One goal established for the Phase 2 RI was to identify RUs (once the size of an RU was set) that exceeded these limits and would have to be excavated. That is, the investigation had to determine the location of the contamination (which RUs) that would have to be remediated. Specifically, the decision was to find all RUs that are greater than 1 ppm PCBs in the top two layers of soil (zero to 8 in. and 8 to 16 in.). EPA chose these strata because their experience has shown that soil removal equipment cannot uniformly remove soil in layers less than 8 in. and that PCBs are not highly mobile in a soil matrix.

The other goal of the Phase 2 investigation was to determine, to a very specific accuracy, the **volume** of soil that would have to be excavated. This volume had to be known to facilitate the cost estimate required in the FS. Typically in a Superfund investigation, a +50%/-30% accuracy is required for cost estimates. Because EPA assumed for this site that all other factors in the cost estimate could be estimated with great accuracy, the only significant uncertainty in the cost estimates was in the volume estimate. EPA indicated that greater than usual accuracy in the cost estimate was required for this site: specifically +30%/-30% accuracy with 90 percent confidence. This therefore was the accuracy required in the volume estimate.

***Summary***

Stage 1 of the Carolina Transformer case study supports concepts discussed in Module 1, Scoping. Specific discussions relate to sections of Submodule 1.2, Site Understanding: evaluation of available data, development of the conceptual model, and use of the LFI. Concepts that are discussed from Submodule 1.3, Initial Evaluation, include preliminary ARARs identification and preliminary risk assessment.

By using the DQO process, the available site history suggested a conceptual site model based on a hot spot pattern. LFI results, however, presented a different pattern that allowed EPA to refine the conceptual model. The LFI results also allowed EPA to focus subsequent investigation by defining specific objectives (i.e., the ability to accurately estimate costs) and by determining the location and volume of contaminated soil.

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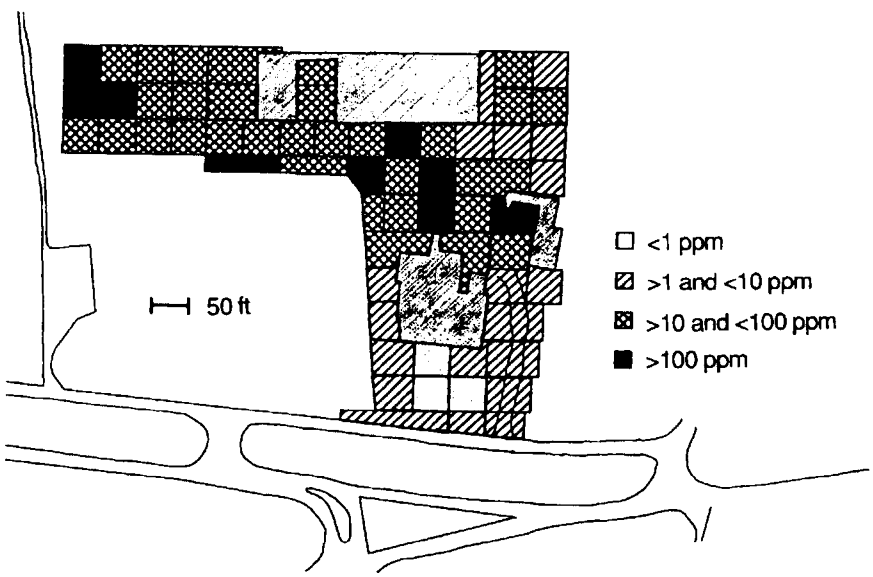
Note A. **Results of the DQO Process for the Carolina Transformer Site.** The site was divided into 62 RUs. A zero- to 2-in. aliquot and an 8- to 10-in. aliquot were taken at each sampling point. Fourteen sampling points were established in each RU within the administration (less contaminated) areas and four sampling points were established in each RU in the operations and storage (more contaminated) areas. The aliquots for each sampling horizon were composited within each RU.

Results of the Phase 1 survey showed that the PCBs were highly variable over the site. PCB contamination varied more than four orders of magnitude in both sampling horizons (zero to 2 in. and 8 to 10 in.). On average, greater contamination existed in the surface layer than at depth. However, contamination at depth was greater in 13 of the remediation areas.

Figures 1 and 2 show the results of the sampling program for the two layers.

Figure 1

**PCB concentrations in 0–2 in. soil layer**




Hatched areas represent buildings or concrete pads

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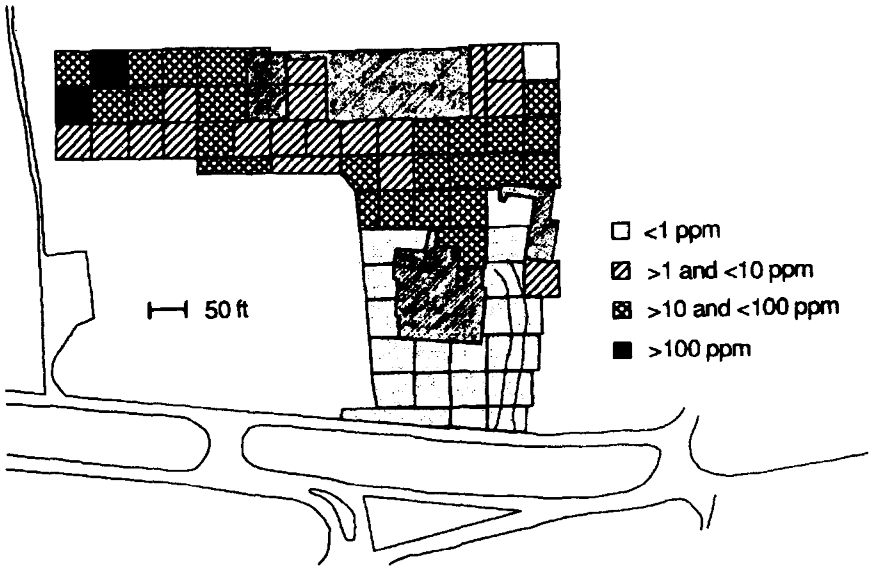
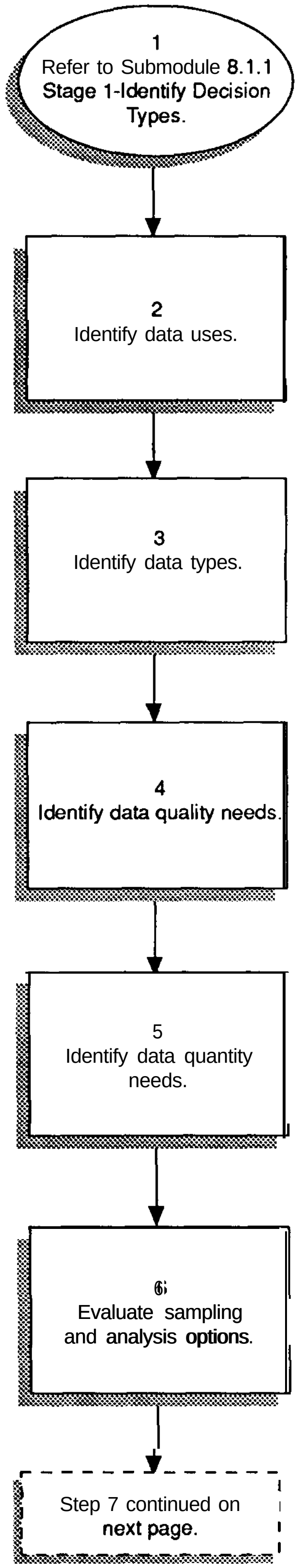
Figure 2

**PCB concentrations in 8–10 in. soil layer**




Hatched areas indicate buildings or concrete pads

# Submodule 8.1.2 Stage 2- Identity Data Uses and Needs



## Submodule 8.1.2 Stage 2–Identify Data Uses and Needs

**Step 1.** Refer to Submodule 8.1.1, Identify Decision Types (Stage 1 DQOs).

**Step 2.** **Identify data uses**. EPA planned to use the data to identify the locations of contaminated soil that would have to be excavated and to estimate the volume of soil that would have to be excavated.

**Step 3.** **Identify data types**. EPA determined the need for the following data: PCB contamination levels for each RU. Composite samples from each of the two sampling horizons (zero to 2 in. and 8 to 10 in.) were to be analyzed for each remediation unit. This provides discrete samples from the upper 2 in. of the assumed contamination lifts: zero to 2 in. for the zero- to 8-in. lift and 8 to 10 in. for the 8 to 16-in. lift.

**Step 4.** **Identify data quality needs**. Contract Laboratory Program (CLP) quality data were not required. The pilot study used a quick-turn-around method for screening for PCBs. The quick-turn-around method was substantially cheaper than the full CLP protocol ($150 vs $1,250). The accuracy obtained with the quick-turn-around method was deemed adequate for the purposes of the decisions required in the FS.

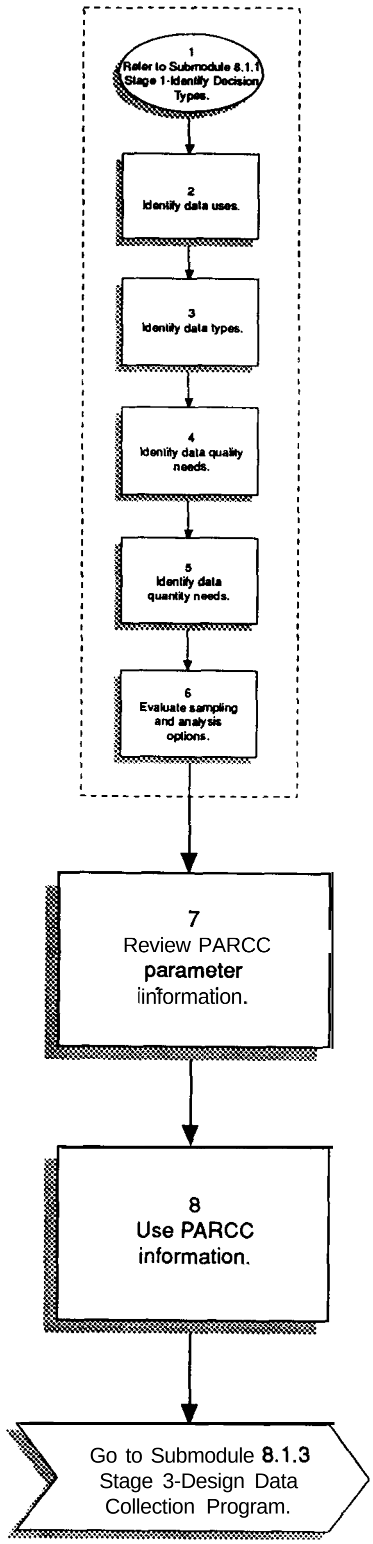
**Step 5.** **Identify data quantity needs**. Because this site involves sampling large areas to measure residual contamination levels, statistical methods for evaluating potential sampling patterns were appropriate. These methods were used to investigate the number of samples that would be required to meet EPA's data quality requirements (+30%/-30% for the volume estimate at 90 percent confidence) and to investigate the sampling cost impacts of various sizes of RUs. The sampling programs varied in this case primarily in terms of the size of the remediation units and the number of samples that would be taken, both of which determine the required data quantity and therefore costs for data collection.

For this site, a Monte Carlo technique was used to randomly assign hypothetical sampling points to a site assumed to be contaminated in a variety of patterns. The Monte Carlo method calculates the concentration that would be indicated by a particular sampling pattern, given the assumed contamination pattern. Because the assumed contamination pattern is known exactly, the bias inherent in various sampling strategies can be measured. Numerous randomly assigned sampling patterns are run (10,000 runs in this case) and the patterns of mean bias, relative bias, and variance or relative sampling error that results are outputs of the modeling. The assumed size of typical contaminated spots, the number of contaminated spots in a sampling area (remediation unit in this case), the size of the sampling areas, and the concentration of the contaminated spots can be varied to explore the data quality that can be obtained through various sampling programs.

**Step 6.** **Evaluate sampling and analysis options**. Both random and regular grid sampling methods were explored with the Monte Carlo technique. It was determined that regular grid-based sampling introduced significant bias in the results for the assumed patterns of contaminated spots. To avoid introducing bias from sampling, random sampling within remediation units was selected.

Other conclusions from the Monte Carlo simulations were (1) sampling error increases as the contaminated spots become smaller; (2) sampling error is not affected by the number of contaminated spots within a remediation unit if the average concentration of the spots is held constant; and (3) sampling error increases as the average concentration of the contaminated spots increases.

## Submodule 8.1.2 Stage 2-Identify Data Uses and Needs (cont.)



EPA was interested in estimating the field and laboratory analysis costs for four potential sizes of remediation units: **1/2 acre** (1 RU = 1 EU), **1/8** acre (1 RU = 1/4 EU), **1/18 acre** (1 RU = 1/9 EU), and **1/32 acre** (1 RU = 1/16 EU). Each size RU requires different total numbers of samples.

Based on the results of the Phase 1 investigation, the site was divided into two areas:

- Operations and storage areas−average concentration of about 30 ppm, much higher than the 1 part per million (ppm) PRG

- Administration areas−average PCB contamination of about 10 ppm, still higher than the PRG of 1 ppm

The basic design was to collect composite samples at each sampling horizon within each RU to determine the average concentrations within the RU. Core samples (zero to 10 in.) were to be taken at each sampling point. The zero- to 2-in. portions were to be composited and the 8- to 10-in. portions were to be separately composited, to yield average concentrations at the surface and at depth. In order to meet the specified DQOs, more samples were required, based on statistical techniques, for the (less contaminated) administration areas than for the operations and storage areas. Greater total numbers of samples were required as the number of RUs increased. Total sampling and analysis costs for the four sizes of RU were as follows:

- 1/2 acre $10,100
- 1/8 acre $22,800
- 1/18 acre $49,860
- 1/32 acre $64,960

EPA decided to use the 1/18-acre RU size. That is, decisions to excavate areas would be based on 1/18-acre areas, and the sampling plan was designed to provide accurate information about whether each 1/18-acre RU needed to be excavated.

The remediation decision rule developed for each depth was if the average PCB level for the nine RUs in any individual EU is greater than 1 ppm, then selected individual RUs will be excavated to reduce the average EU PCB concentration to less than 1 ppm. Note that this may result in leaving some RUs with PCB levels above 1 ppm as long as the EU average is below 1 ppm.

**Step 7.** **Review PARCC parameter information**. The PARCC requirements of the data were expected to be acceptable on the basis of detailed modeling and accurate field and laboratory work. Based on experience, EPA assumed the precision and accuracy were within 30 percent for any individual sample. The representativeness was evaluated in detail and optimized through the use of the Monte Carlo simulations. The quality requirement (volume estimates within +30%/-30% at a 90 percent confidence level) was an input to the Monte Carlo simulation, and it was to this requirement that the simulation optimized the sampling strategy.

**Step 8.** **Use PARCC information**. The PARCC requirements were used in establishing the sampling plan. For precision, accuracy, and representativeness, it was possible to specify

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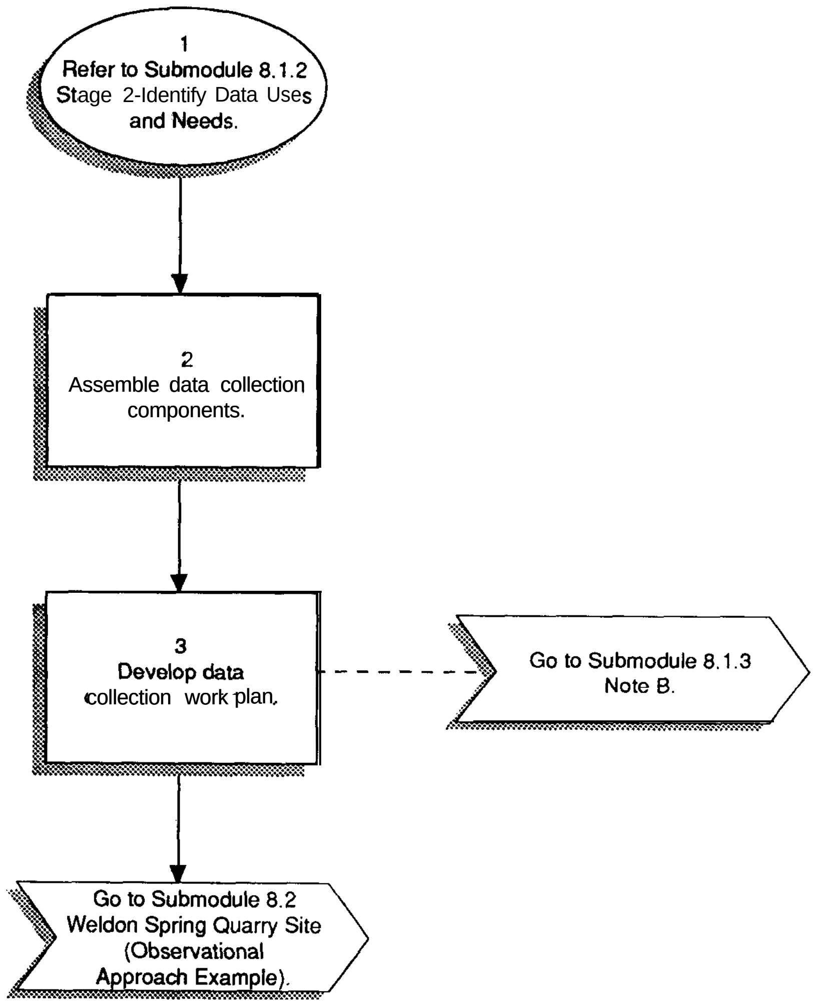
and use quantitative measures.  Quantitative measures were not developed for completeness or comparability until the work plan was developed.

***Summary***

Stage 2 of the DQO process relates directly to Submodules 1.3, Initial Evaluations and 1.4, Data Collection. Specifically, PRGs are established and DQOs are developed.

EPA used Stage 2 of the DQO process to focus sampling investigations on collecting specific quantities and types of data to support specific remedial decisions.  Specific opportunities for streamlining were identified by the ability to use non-CLP data and field screening techniques, and by developing a remediation decision rule. The decision rule specified how contaminated EUs would be identified and when remediation could be stopped.

# Submodule 8.1.3 Stage 3-Design Data Collection Program



## Submodule 8.1.3 Stage 3–Design Data Collection Program

**Step 1.** Refer to Submodule 8.1.2, Identify Data Uses and Needs (Stage 2 DQOs).

**Step 2.** **Assemble data collection components.** This step was not necessary for the Carolina Transformer site, because only one type of data (PCBs in soil) is being collected for a limited set of data uses (locations and volume of contaminated soil). In situations where numerous site questions are being addressed through a single sampling effort, it is necessary to compile tables of all of the samples that will be collected, the needs and uses for the data, and the quality objectives for each datum. Submodule 1.4, Data Collection Plan, provides guidance on developing data collection plans.

**Step 3.** **Develop data collection work plan**. Submodule 8.1.1, Note A, describes the sampling plan arrived at by use of the DQO process and the acceptability of the sampling plan to EPA. The Sampling and Analysis Plan (SAP) and the Quality Assurance Project Plan (QAPP) are parts of the work plan for the Phase 2 RI. All of the aspects and outputs of the DQO process used in developing the sampling strategy should be included in the work plan, as justification and basis for the sampling strategy used. Submodule 8.1.3, Note B, provides a summary of the Phase 2 sampling results. Submodule 1.5, Work Plan Preparation, provides guidance on developing SAPs, QAPPs, and the work plan.

***Summary***

Stage 3 of the DQO process supports Submodules 1.4, Data Collection Plan and 1.5, Work Plan Preparation.

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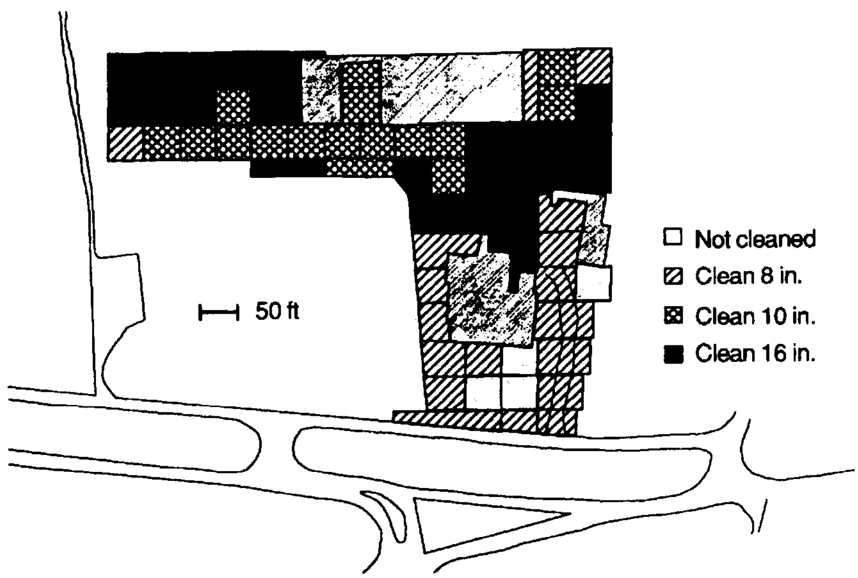
<u>Note B.</u> **<u>Phase 2 RI Results</u>.** To estimate the soil volume, the following cleanup strategy was assumed in the FS. The surface soil was considered to be clean if the PCB contamination was below 1 ppm. An excavated area can be backfilled with clean soil if the PCB contamination is below 10 ppm and at a depth greater than 10 in. Three different excavation depths are used in the cleanup strategy: 8, 10, and 16 in. The total amount of soil to be excavated was estimated to be 5,389 $yd^2$. Figure 3 shows the cleanup strategy developed for the site.

Figure 3

**Cleanup strategy for the site**

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# Submodule 8.2 Weldon Spring Quarry Site (Observational Approach Example)

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| 8.2 Weldon Spring Quarry Site (Observational Approach Example) |
|---|
| • Planning |
| • Assessment and Selection |

## Submodule 8.2  Weldon Spring Quarry Site (Observational Approach Example)

***Background***

Uncertainty is a key technical factor in hazardous and radioactive waste site remediations.  It can lead to unreasonable data gathering exercises if the point of diminishing information is not recognized.  Proper use of DQOs can assist in defining this point.  Engineering under uncertainty is not unique to waste site remediation. Approaches have been used at other sites for recognition of and response to substantial uncertainty.

The observational approach, traditionally applied in geotechnical engineering, has a number of key elements applicable to waste site remediation.  The main contributions of the observational approach are (1) remedial design based on most probable site conditions; (2) identification of reasonable deviations from these conditions; (3) identification of parameters for detection of deviations during remediation; and (4) preparation of contingency plans for each potential deviation.

DOE used the observational approach at the Weldon Spring Quarry to streamline the RI/FS because the waste could not be characterized on the basis of type (e.g., structural steel, process equipment, drums, concrete) or placement.  This case study provides an example of integrating tenets of the observational approach into the FS and decision documents.

The Weldon Spring Quarry is an OU at the Weldon Spring Site; a DOE facility located near St. Charles, Missouri.  EPA placed the OU on the National Priorities List (NPL) in 1987.  The U.S. Army constructed the quarry and used it from 1941 through 1946 for the disposal of chemically contaminated materials.  The Atomic Energy Commission (AEC) acquired the quarry in 1960 as part of a uranium feed material plant that it was constructing.  DOE disposed of wastes from the feed material plant into the quarry.  This waste disposal included drummed and uncontained thorium, uranium, contaminated building rubble, process equipment, and nitroaromatic residues from cleanup of the old ordnance works.  Throughout the operation of the quarry, deposited wastes included structural steel, drums of solid and liquid radioactive and chemical wastes, process equipment, concrete, and soil.

The quarry is surrounded by the Weldon Spring Wildlife Area.  The Howell Island Wildlife Area is immediately west of the quarry across the Missouri River.  The Missouri River is located approximately 1 mile to the southeast of the quarry.  The Femme Osage Slough is located between the quarry and the river, about 0.15 miles south of the quarry.  In addition, an alluvial well field that supplies drinking water to more than 60,000 residents is located about 0.5 to 1 mile southeast and downgradient of the quarry.  As part of previous activities at the site, DOE installed 26 groundwater monitoring wells on the north and south sides of the slough. Data from these wells show that groundwater between the quarry and the slough is contaminated with chemical and radioactive constituents leaking from the quarry.  However, the slough appears to act as a hydrologic barrier to contaminant migration south of the slough.

The quarry was excavated in a limestone bluff above the Missouri River floodplain.  The limestone formation contains cracks and fissures and the waste is in hydraulic communication with the local groundwater.  The quarry is approximately 1,100 ft long, 450 ft wide, and covers about 9 acres.  DOE estimates that approximately 95,000 cubic yards of radioactively and chemically contaminated waste have been placed in the quarry.

The area surrounding the quarry is sparsely populated, but sensitive human receptors are located in the vicinity. The quarry is adjacent to State Route 94, a well-traveled, north-south highway through the area.  In addition, the surrounding wildlife area receives several thousand recreational visitors each year.  A permanently occupied residence is located about 1 mile to the southwest of the quarry.  Francis Howell

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High School is located on Route 94 about 4.5 miles northeast of the quarry and serves approximately 2,300 students and faculty.

Protection of human health and the environment was the primary objective of this OU.  This case study is an interim remedial action and focuses on removal of the bulk waste from the OU.  Subsequent remediation of the residual contamination will be addressed in a later action.

The observational approach process is explained in detail in Submodule 7 as part of the SAFER method.  As applied at this site, the observational approach included the following elements:

1. Identification of expected site conditions through the development of a site conceptual model

2. Development of remedial action alternatives based on available information, without recourse to additional field investigation

3. Identification of potential deviations from the expected conditions that might be encountered during remediation, and development of contingency plans to address each of the potential deviations

4. Evaluation of the remedial alternatives, in part, on the basis of the capacity of each alternative to accommodate the potential deviations from expected conditions

By very explicitly addressing each of these points, the observational approach allows a remedial decision to be made and remediation to begin despite uncertainties that exist.  Public consideration of and comment on the alternatives are more effective when the stakeholders are presented the uncertainties and the planned means of dealing with them.

***Organization***

Submodule 8.2 discusses the following:

- Submodule 8.2.1−Planning
- Submodule 8.2.2−Assessment and Selection

In addition, more detailed information is provided in the following notes:

- Submodule 8.2.1, Note A−Weldon Spring Quarry Simplified Conceptual Model
- Submodule 8.2.2, Note A−Engineering Uncertainties
- Submodule 8.2.2, Note B−Environmental Uncertainties

***Sources***

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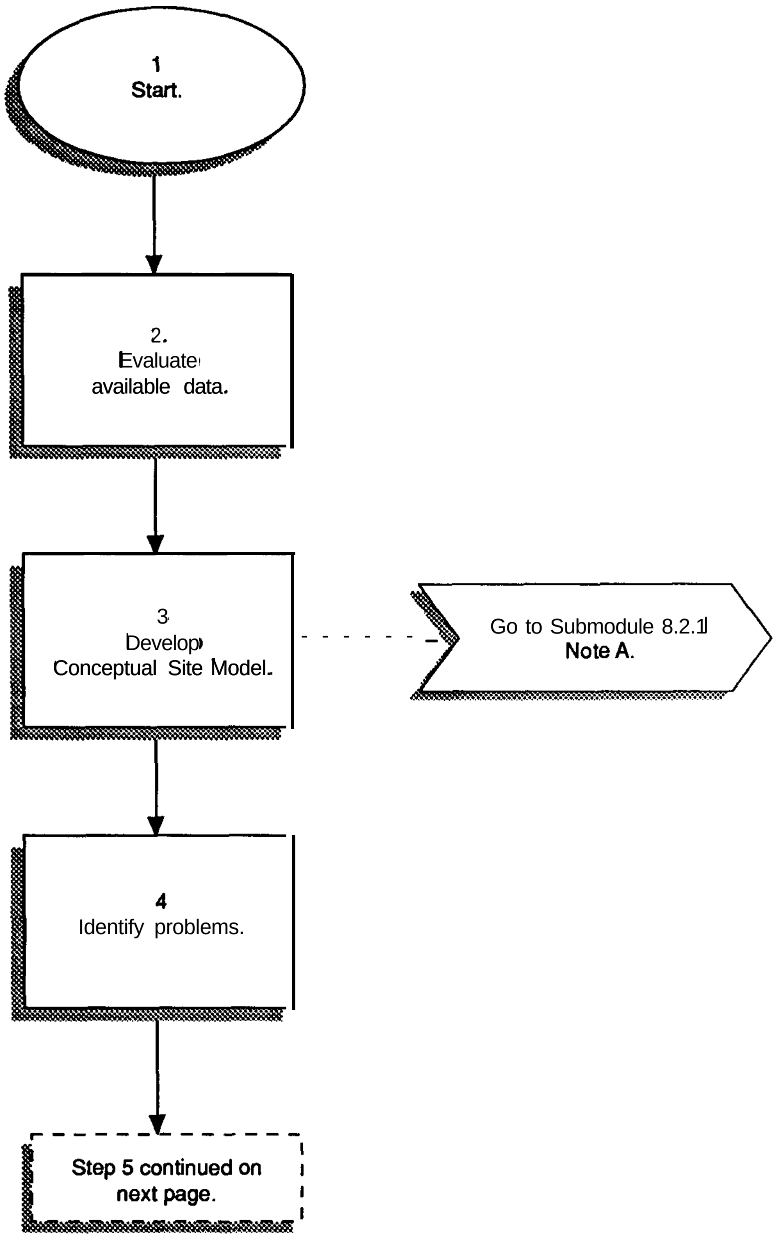
# Submodule 8.2.1 Planning

NOTE:
Submodule 1.2 Site Understanding provides guidance in evaluating available data and developing conceptual site models.



## Submodule 8.2.1 Planning

**Step 1.** Start.

**Step 2.** **Evaluate available data.** A good understanding of the available data is important to the subsequent planning steps. A considerable amount of data was available at the Weldon Spring Quarry, including groundwater monitoring, waste characterization, and physical site conditions. The groundwater monitoring data indicated that contamination was migrating toward the municipal well field; however, the contamination did not appear to have migrated beyond a small slough located between the quarry and the well field. Although there was no indication of contamination in the well field, serious concerns were raised about the long-term integrity and reliability of that resource. Insufficient data were available for understanding the hydrogeologic system or for predicting with confidence that the contamination would not eventually affect the well field.

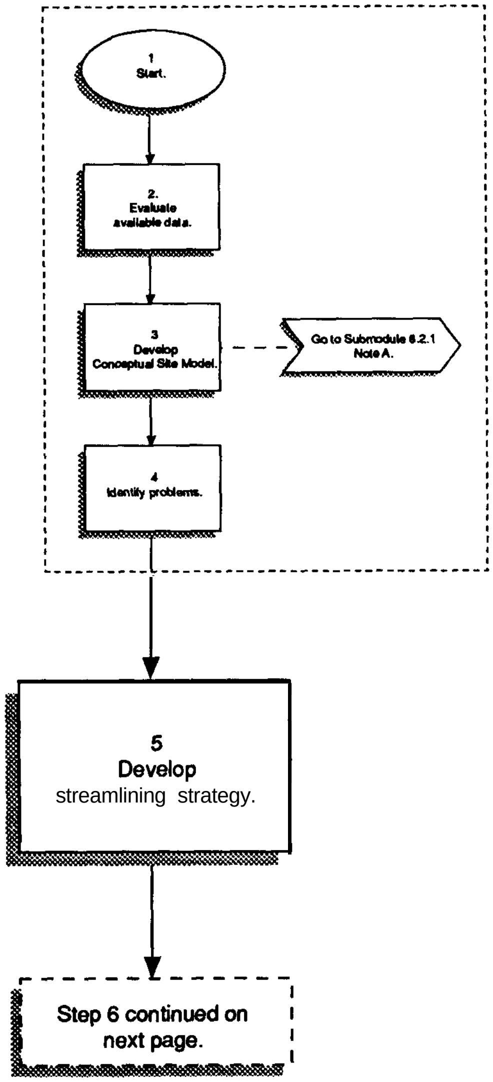
Other key data included the results of previous sampling of the bulk waste in the quarry. These data were fairly comprehensive for assessing the radiological aspects of the waste and, with regard to chemical characterization, were sufficient for a general understanding of the nature of the contaminants. The data were consistent with expectations, given the known disposal history.

Information was available on the geology, hydrogeology, and physical conditions of the quarry as well as pumping tests results. Possibly the most useful historic information, was a series of photographs taken in the 1950s and 1960s that show the type of wastes in the quarry, the original configuration of the floor and walls, and the method of waste hauling and placement. Guidance on evaluating available data is provided in Submodule 1.2, Site Understanding.

**Step 3.** **Develop conceptual site model.** A conceptual site model was developed on the basis of available data. As discussed in Module 1, Scoping, the conceptual site model combines the available data into an overall understanding of the site. The Weldon Spring Quarry data indicated that (1) there is approximately 95,000 cubic yards of radioactive and chemically contaminated waste in a heterogeneous mixture, approximately half of which is in contact with the water table; (2) contaminants are migrating through cracks and fissures in the limestone walls and floor into an alluvial system on the Missouri River floodplain; (3) there are hot spots of uranium and nitroaromatics between the quarry and the slough; and (4) monitoring continues to show that the well field has not been affected. Submodule 8.2.1, Note A, provides a simplified conceptual model of the Weldon Spring Quarry. Additional information on conceptual models is provided in Submodule 1.2, Site Understanding.

**Step 4.** **Identify problems.** The conceptual model identified the obvious problem that must be addressed: how to keep the wastes in the quarry from contaminating the nearby well field. Additional studies were required for understanding the hydrogeologic conditions and specific migration pathways; however, leaving the wastes in the quarry over any long period of time was not determined as an option. Factors that contribute to the quarry's unsuitability as a repository for the wastes included (1) the site conditions (fractured limestone and shallow water table, upgradient of a municipal well field) were not compatible with the requirements for a long-term radioactive waste disposal area and (2) the low degree of assurance that the contamination would not eventually migrate to the well field. It was therefore determined that the remedial objective for the quarry OU was to remove the quarry waste. Waste residues and contaminated soils would be treated as a separate OU.

# Submodule 8.2.1 Planning (cont.)



The amount of available data, the conditions at the site, and the limited number of alternatives for effectively dealing with the quarry wastes all contributed to a decision to rely as much as possible on data already in hand and to streamline any further data collection. The overriding factor in support of limiting data collection was the ability to obtain agreement from the regulatory agencies that the available data were sufficient to support a remedial action decision. The basis for this agreement included the following factors: (1) the radiological data were fairly complete; (2) the chemical data were sufficient for understanding the types of contaminants and ranges of concentrations likely to be encountered; (3) the technical impracticability of characterizing the wastes in place; and (4) no amount of data would allow complete waste characterization, where conditions could be predicted from borehole to borehole. Based on these factors, the RI was developed using only available data. Additional information on initial evaluation of data and site characterization is available in Submodule 1.3, Initial Evaluation and in Module 2, Site Characterization.

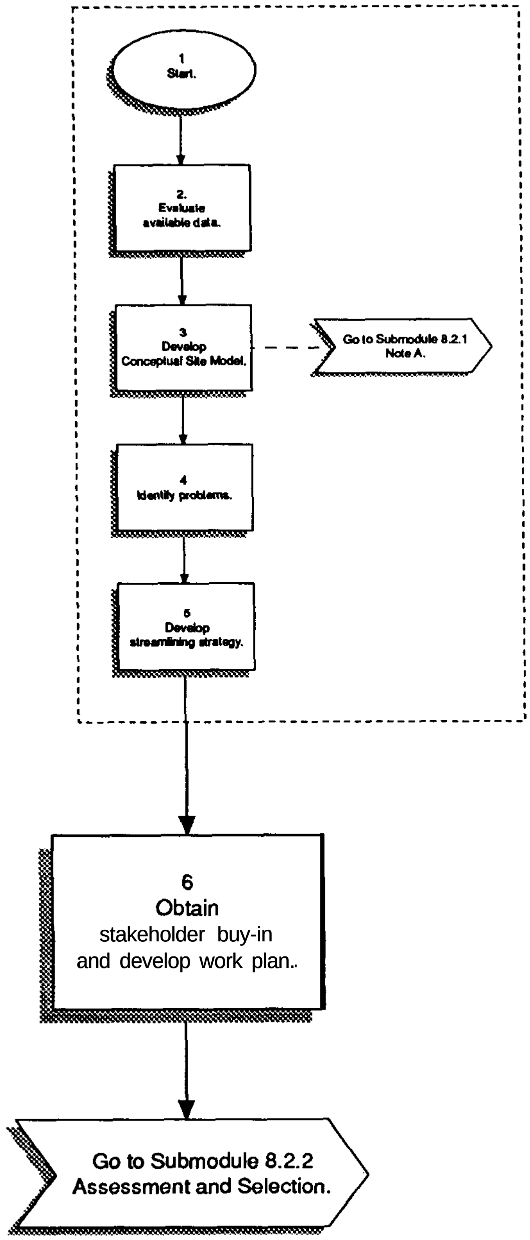
**Step 5.** **Develop streamlining strategy.** Because of the urgency of the problems at the site and agreement that the problems were sufficiently understood, the next step was to define the optimal strategy for achieving the remedial objective of removing bulk waste from the quarry. To develop a comprehensive remedial strategy, a series of discussions was held by the DOE project team. Based on probable site conditions, the following media-specific OUs could be identified: the standing water in the quarry, the quarry waste, the quarry residuals and surrounding soil, and the groundwater. This definition of the OUs would allow pursuit of accelerated actions for the surface water in the quarry and for source control. Following removal of the waste from the quarry, actions would be taken for final cleanup of the quarry residuals and the groundwater.

The regulators concluded that an interim RI/FS would be required to support remedy selection for the source removal action. Reasons included cost, schedule, community concerns, and the overall scope and magnitude of the project. EPA agreed to a focused or streamlined RI/FS effort.

The remedial strategy included the conclusion that a comprehensive baseline risk assessment could not be supported with the existing information on pathways. A limited baseline risk *evaluation*, therefore, would be developed to support the decision. The preferred alternative was anticipated to be waste removal. However, to comply with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and National Environmental Policy Act (NEPA), a limited number of alternative strategies were investigated in the focused feasibility study. An interim response action also was pursued to treat the contaminated water ponded in the quarry and thereby dewater the wastes. The scope of the source control OU was expected to be removal of as much waste as possible, using conventional construction equipment. Any residual contamination remaining in the cracks and fissures of the rock would be addressed in the follow-on quarry residuals and surrounding soils OU.

The most important aspect of streamlining the process was developing a strategy for managing the uncertainties that were known to exist. There were both engineering uncertainties (e.g., excavation, segregation, handling, and managing the wastes) and environmental uncertainties (e.g., contaminant levels, worker protection, and fugitive emissions control). It was determined that these uncertainties would be managed through the techniques of the observational approach:

# Submodule 8.2.1 Planning (cont.)



(1) Identification of potential deviations from the expected conditions that might be encountered during remediation

(2) Development of contingency plans to address each of the potential deviations

(3) Evaluation of the remedial alternatives, in part, on the basis of the ability of each alternative to accommodate the potential deviations from expected conditions, if they occur

By very explicitly addressing each of the points, the observational approach allows a remedial decision to be made and remediation to begin despite the uncertainties that exist. Public consideration of and comment on the alternatives are made more effective when the stakeholders are presented the uncertainties and the planned means of dealing with them.

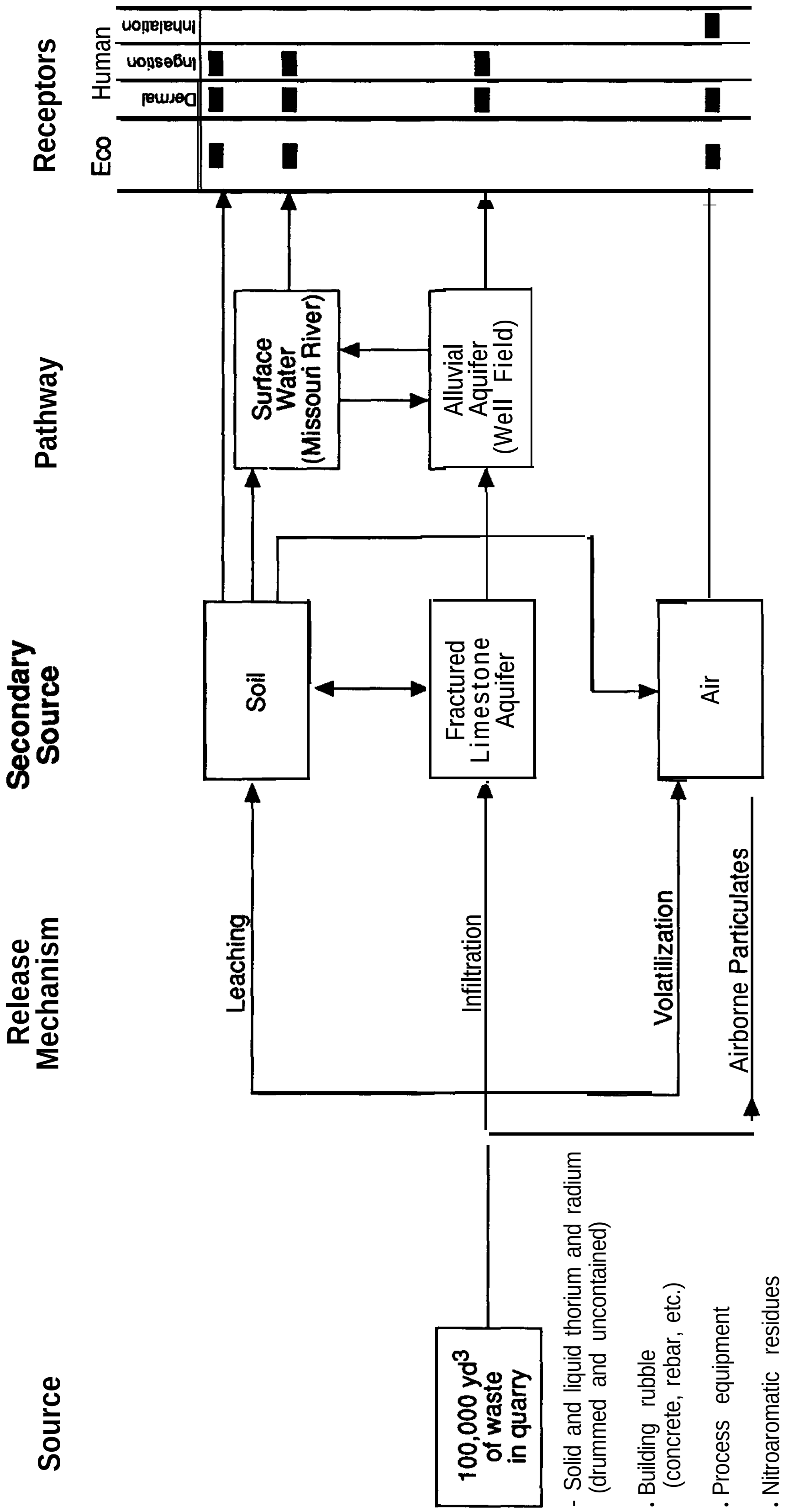
Finally, the remedial strategy included developing integrated CERCLA-NEPA documents and determining that the focused RI/FS would incorporate NEPA requirements.

**Step 6.** **Obtain stakeholder buy-in and develop work plan.** With an overall compliance strategy formulated, all the technical rationale and arguments were presented in a series of position papers that were reviewed and revised by DOE, EPA, and the respective state agency (although the state is not a signator of the Federal Facilities Agreement, their agreement was considered important). The primary purpose of the position papers was to inform and obtain buy-in from the regulators consistently throughout the RI/FS, instead of waiting until higher level documents (such as the RI/FS work plan) were supplied.

When informal concurrence on the position papers was achieved, the strategies were integrated into the work plan. The work plan presented streamlining strategies for accelerating source control actions at the quarry. The work plan was issued for public review and comment; when finalized, it guided the course of action at the quarry.

***Summary***

The planning phase of the Weldon Spring Quarry supports concepts discussed in Submodule 1.1, Project Management Approach; Submodule 1.2, Site Understanding; and Submodule 1.3, Initial Evaluation. By maximizing the use of available data and with frequent informal communication (e.g., position papers) with the extended project team, DOE developed a work plan that resulted in a very focused RI.

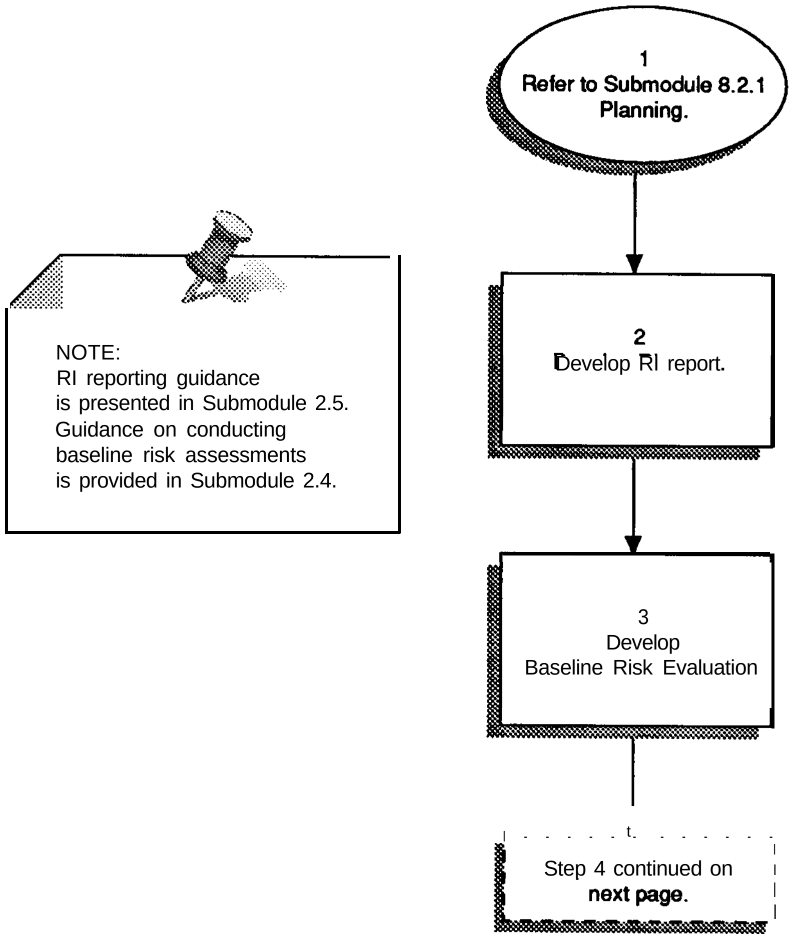

Source
100,000 yd$^3$ of waste in quarry
- Solid and liquid thorium and radium (drummed and uncontained)
. Building rubble (concrete, rebar, etc.)
. Process equipment
. Nitroaromatic residues
Release Mechanism
Leaching
Infiltration
Volatilization
Airborne Particulates
Secondary Source
Soil
Fractured Limestone Aquifer
Air
Pathway
Surface Water (Missouri River)
Alluvial Aquifer (Well Field)
Receptors
Eco
Human
Dermal
Ingestion
Inhalation

<u>**Note A**</u>**.** <u>**Simplified Conceptual Model**</u>**.** The conceptual site model was developed on the basis of available data that included Army and AEC records as well as the initial site characterization efforts during the early 1980s. The Weldon Spring Quarry data indicated (1) the existence of a heterogeneous mixture of approximately 100,000 cubic yards of radioactive and chemically contaminated waste, approximately half of which is in contact with the water table; (2) contaminants migrating through cracks in solution channels in the limestone walls and floor into an alluvial system on the Missouri River floodplain; (3) the existence of hot spots of uranium and nitroaromatics between the quarry and the slough; and (4) continued monitoring data showing that the well field has not been affected.

This conceptual site model combines the available data into an overall understanding of the site, including probable conditions and uncertainties. For instance, probable conditions for groundwater are that contamination exists in the fractured limestone aquifer. Similarly, data support the probable condition that contamination has not migrated to the alluvial aquifer from the fractured limestone aquifer. The conceptual model indicates a pathway between these aquifers; the exact pathway for and rate of contaminant migration are uncertain.

Additional information on the use of conceptual models can be found in Module 1, Scoping. Conceptual models are developed during the scoping stage and provide a summarized site picture that is updated as new information is accumulated.

# Submodule 8.2.2 Assessment and Selection



## Submodule 8.2.2 Assessment and Selection

**Step 1.** Refer to Submodule 8.2.1, Planning.

**Step 2.** **Develop RI report.** The data used to develop the RI report consisted of manifest information, results of previous sampling efforts, and data from ongoing environmental monitoring activities. Thorough analysis and interpretation of conditions in the quarry were critical during development of the RI because the ability to collect new field data was technically limited. The RI report was an integrated CERCLA-NEPA document. From a practical standpoint, this meant including analyses and discussions on cultural resources, land use, and the affected environment at the Weldon Spring Quarry. Elements of the document were reviewed by EPA and the state on an ongoing basis to ensure that the regulators were informed about project decisions. In addition to informal communications, responsiveness summaries developed by the regulators were furnished with revisions to the document.

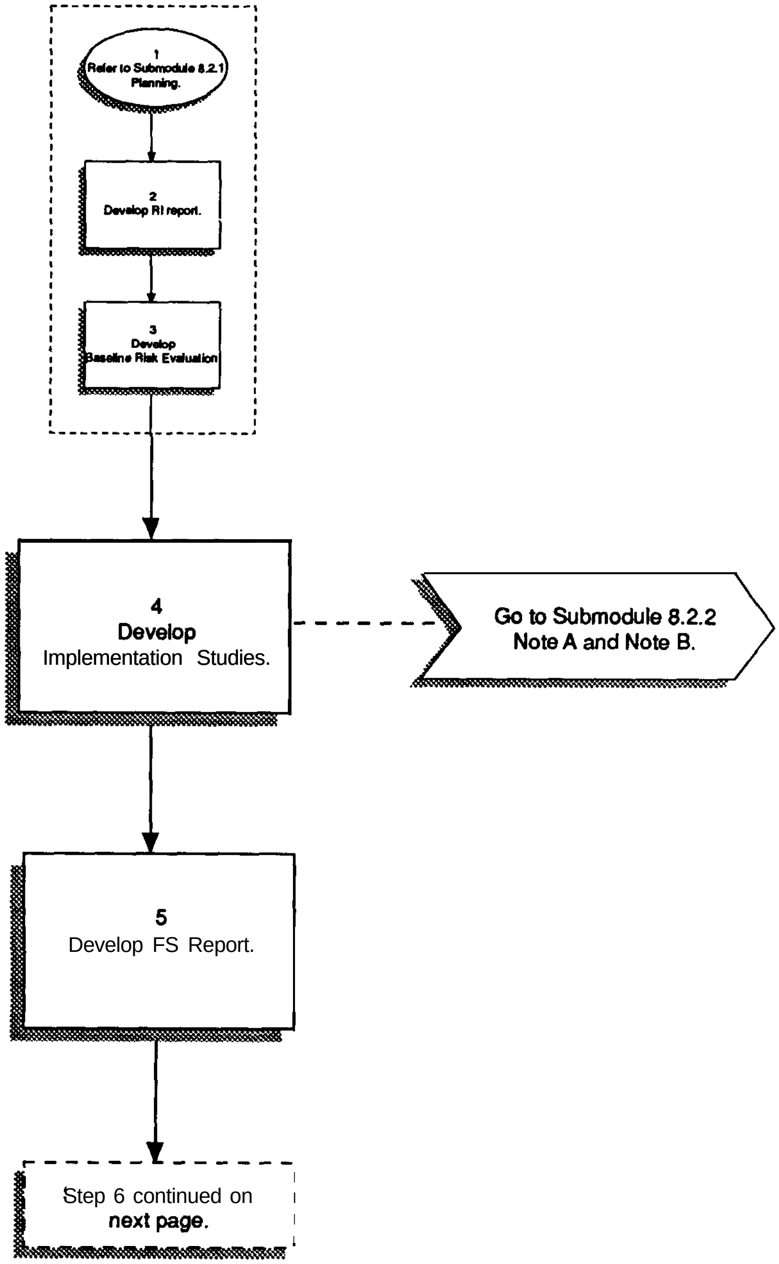
As noted in Submodule 8.2.1, the Weldon Spring Quarry was segregated into several OUs by medium. During the development of an RI to facilitate streamlining, it is important to focus on the scope of the OU and not to address the comprehensive problem at a site. One of the most difficult aspects of preparing the RI for the bulk quarry wastes at Weldon Spring Quarry was resisting the tendency to be comprehensive in addressing the entire quarry area. For example, discussions about hydrogeology were limited to the level of detail required to ensure that the site could be adequately monitored during waste removal. Submodule 2.5, Reporting, provides detail on producing RI reports. Submodule 2.5, Note A, represents a suggested RI report format.

**Step 3.** **Develop baseline risk evaluation.** A baseline risk assessment was not possible because insufficient information existed to assess complete exposure pathways for transport mechanisms via groundwater. However, a baseline risk evaluation (BRE) was prepared for the bulk wastes in the quarry. Limiting the scope of the analysis to the quarry wastes was an innovative approach and important for ensuring the continued streamlining of the OU. This approach was important because it was assumed that the risk posed via groundwater was the most significant for the quarry based on the conceptual model (see Submodule 8.2.1, Note A). The BRE revealed that the need for action was determined on the basis of the quantitive risks under a trespasser exposure scenario and the qualitative risks expected from future hypothetical exposure resulting from groundwater contaminant migration.

Formal and informal communication with regulators was continued throughout the development of the BRE. Once formally developed, the BRE was also subject to regulatory review and comment responses similar to the RI report.

The BRE supported the assumption that the likely preferred alternative would involve removal of the waste from the quarry. Alternatives to waste excavation were developed as part of the FS process. These included no action, in-situ waste stabilization or hydraulic isolation, and ex-situ alternatives such as vitrification. The in-situ and ex-situ alternatives were screened out on the basis of implementability, long-term effectiveness, and compliance with ARARs. However, the alternative to delay interim action for more final actions met the major screening criteria. Initial FS activities of alternative

# Submodule 8.2.2 Assessment and Selection (cont.)




NOTE:
Guidance on development and evaluation of alternatives is provided in Modules 4 and 5. Submodule 5.3 provides guidance on developing FS reports.

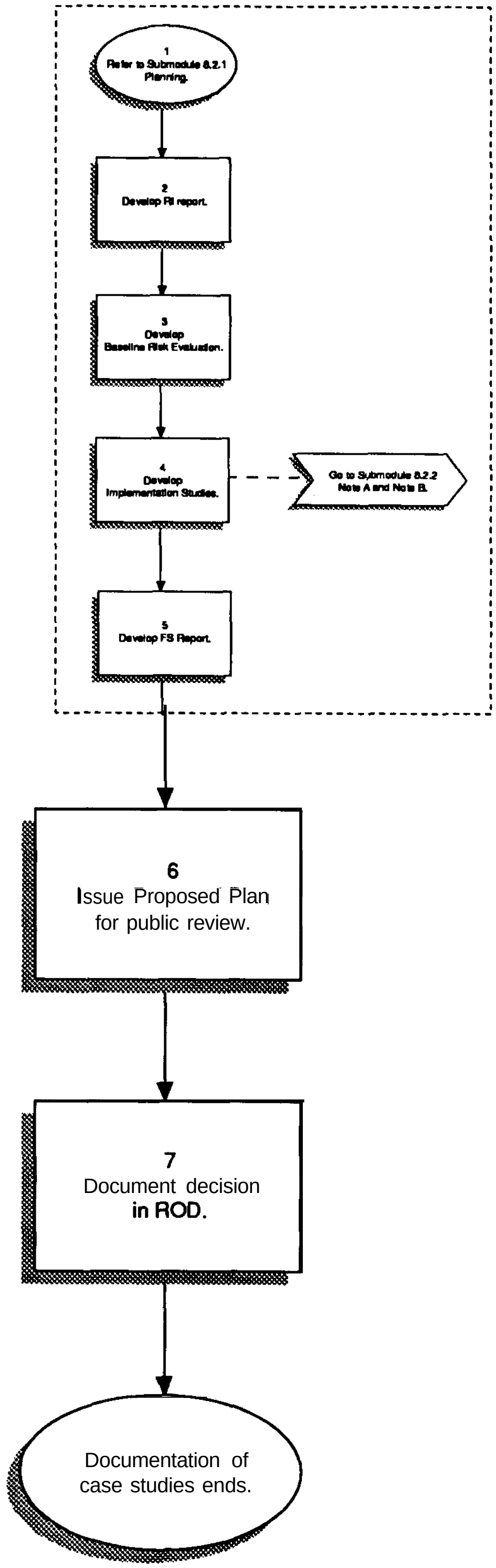
identification and screening resulted in narrowing the field to waste excavation, delaying action pending development of the chemical plant ROD, and no action.  Submodule 2.4, Baseline Risk Assessment, provides guidance on conducting baseline risk assessments. Submodule 2.5, Note B, provides guidance on documenting risk assessments.

**Step 4.** **Develop implementation studies.**  By using the focused screening criteria, the FS narrowed the alternatives to waste excavation.  The most important remaining technical issue was to determine if waste removal could be performed while maintaining worker safety and protecting the public from risks.  This issue resulted from uncertainties including the nature of the wastes, the method of placement, and the potential to encounter unanticipated conditions.  Because of the number of uncertainties, the traditional study-design-build approach to excavating and storing the waste was not feasible.  Additional data collection would have involved a number of drawbacks–mainly the technical infeasibility of obtaining the data.  An alternative approach to collecting additional data was managing the uncertainties in ensuring protection of worker safety and public health during implementation.  The observational approach was identified as an alternative approach that provided a framework to accommodate implementation uncertainties.

Two key implementation studies were performed during the detailed analysis phase of the FS to address the waste removal issue.  These studies evaluated (1) the engineering uncertainties of removing the wastes (equipment, operations, material properties, productivity, etc.) and (2) the environmental uncertainties of removing the wastes (environmental monitoring, health and safety, contingency plans, etc.).  A great number of "what if" scenarios was raised during the public review.  The implementation studies provided an analysis of these scenarios and provided an opportunity to increase public confidence.  The results included defining the likelihood of a scenario occurring, and the contingency response plans and engineering controls that could be applied to mitigate the situation.  These implementation studies and observational approach analyses provided the necessary information to complete the RI/FS process and to proceed with Remedial Design/Remedial Action (RD/RA) activities. Submodule 8.2.2, Notes A and B, provide additional detail on these studies and the use of the observational approach at Weldon Spring Quarry.  Module 4, Development and Screening of Alternatives, and Module 5, Detailed Analysis of Alternatives, provide detailed guidance on developing and evaluating alternatives.

**Step 5.** **Develop FS report.**  The FS report was completed by finalizing the detailed analysis of alternatives with the information from the engineering and environmental implementation studies.  The results of the NEPA analyses associated with environmental impacts and worker risks were integrated into the FS.  The FS presented detailed descriptions of the waste removal scenario and a technical discussion that the wastes could be removed safely, if removal were the chosen alternative.  Submodule 5.3, Feasibility Study Report, provides guidance on developing FS reports.

# Submodule 8.2.2 Assessment and Selection (cont.)




NOTE:
Submodule 6.1 provides guidance on developing Proposed Plans. Submodule 6.2 provides guidance on developing RODs.

**Step 6.** **Issue Proposed Plan for public review.** After DOE, EPA, and the state performed final reviews of the integrated RI/FS Environmental Assessment (EA) documents, a proposed plan was issued for public review. The proposed plan identified the preferred alternative as excavation of the bulk wastes, hauling the wastes to the chemical plant area along a dedicated haul road, and placing the waste in temporary controlled storage pending the final Weldon Spring Quarry sitewide waste disposal decision.

The proposed plan received a generally favorable response from the public, who strongly believed that the waste needed to be removed from the quarry. The primary point of public interest was whether or not the waste removal work could be performed safely. The implementation plans developed during the FS were used to support the preferred alternative and to help communicate to the public how the uncertainties would be managed to effectively ensure worker safety and reduce human health risk. Submodule 8.2.2, Notes A and B, provide additional detail on these topics. Submodule 6.1, Proposed Plan, provides guidance on developing the Proposed Plan.

**Step 7.** **Document decision in ROD.** Responses to public comments were included with the ROD that was signed in September 1990. The ROD served as the decision document under CERCLA. A Finding Of No Significant Impact (FONSI) was issued in accordance with NEPA.

The ROD was structured to facilitate the observational approach. It addressed the identified uncertainties and discussed the contingency plans that had been developed. The flexibility to make adjustments to the remedial approach during remediation was thus built into the ROD. Submodule 6.2, Record of Decision, provides guidance on developing the ROD.

**Documentation of case studies ends.**

***Summary***

The assessment and selection phase of the Weldon Spring Quarry case study supports concepts discussed in Submodules 2.4 and 2.5 and in Modules 4, 5, and 6. By establishing probable conditions and identifying reasonable deviations, DOE was able to articulate to the extended project team and the stakeholders their plan for managing uncertainty during remediation.

| Expected Conditions | Potential Deviations | Mechanisms to Identify Deviations | Contingency Design |
|---|---|---|---|
| **Stable High Wall** | • Removal of toe support<br>• Increased traffic and vibrations | • Direct measurement | • Rock bolt<br>• Wire mesh<br>• Benches |
| **Adequate Dewatering** | • Unable to dewater certain areas of the quarry | • Monitor well water level readings<br>• Direct observation | • Drainage trenches<br>• Dewatering wells |
| **Stable Working Face** | • Waste will not support equipment | • Operator feedback<br>• Degree of dewatering<br>• Settlement/sloughing/slumping | • Alternative excavation method<br>• Excavate thinner lifts |
| **Excavating Equipment Effective** | • Inability to remove or extract<br>• Inability to sort<br>• Inability to maneuver | • Direct observation | • Alternative excavation method |
| **Buried Access Road** | • Unuseable access to quarry floor | • Direct observation | • Alternative excavation method |

**Note A.** **Engineering Uncertainties**. An important part of the FS is to identify and evaluate uncertainties that would affect implementation. For this site, a preliminary engineering report (PER), developed as part of the FS, served as an engineering planning tool. The implementation scenarios were also developed as part of the PER and were used as a basis for some of the NEPA analyses regarding air quality impacts, worker risks, etc. The PER served a useful purpose in developing conceptual and final design tasks. These engineering planning efforts and implementation studies described the known or expected site conditions; identified reasonably foreseeable deviations (such as the degree of dewatering of the waste, the ability of equipment to work an excavation face, the stability of the highwall adjacent to a nearby state highway, and the productivity of the excavating equipment); and categorized these deviations according to the types of responses or mitigative measures required.

| | | Expected Conditions | Potential Deviations | Working Face Action Level | Fenceline Action Level | Engineering Controls |
|---|---|---|---|---|---|---|
| **Vapors** | Radon | Above 3 pCi/l progressively lower | Levels higher than expected | 10 DAC hrs-wk | 3 pCi/l or .02 WL | • Water sprays<br>• Reduce surface area<br>• Surface sealant (50-85%)<br>• Mechanical ventilators<br>• Covers (80-95%) |
| | VOCs | Below 5 ppm | | 5 ppm | 1/10 TLV | |
| **Dust** | Radioparticulates | Below respiratory action levels | Concentrations exceed respiratory action levels | 1 mg/m$^3$<br>500 mrem<br>3.2x10$^{-13}$ µCi/ml | .25 mg/m$^3$<br>Gross alpha<br>2.1x10$^{-14}$ µCi/ml | • Water sprays<br>• Surface sealant<br>• Covers |
| | Nitroaromatics | | | 0.25 mg/m$^3$ | 0.5 mg/m$^3$ | |
| **Gamma** | | Exposure rates at most tens of mrem/hr | Levels higher than expected | 5 mrem/hr | 100 mrem annual | • Limit working area<br>• Remote excavation |
| **Explosives** | | Concentrations less than 10% | • Concentrations higher than 10%<br>• Hot spots | - - | - - | • Water sprays<br>• Oil/water sprays |
| **Groundwater** | | • Gradient reversal<br>• Little chance for migration | • Preferential pathways<br>• Rapid transport | NA | Statistically significant increase | • Interceptor wells<br>• Cut-off wall<br>• Shut down municipal well(s) |

**Note B.** **Environmental Uncertainties**. A key step in implementing the observational approach is brainstorming and documenting potential deviations. The list of deviations can be distributed for management and peer review to help ensure that all reasonable deviations have been considered.

Uncertainties are sometimes identified that cannot be handled as deviations and must be addressed through additional analysis or studies. One such scenario at the quarry was the potential for encountering concentrations of nitroaromatics that could be shock sensitive. Project management responded by acquiring expert services to evaluate the proposed action and to make appropriate recommendations. The study concluded that the work could be conducted safely and recommended several precautionary measures.

The observational approach was used in identifying environmental uncertainties related to the waste characteristics and potential deviations. For this site, a Draft Operational Environmental Safety and Health Plan was developed to accomplish the following:

- Summarize the activities expected during water treatment operations and waste excavation, transportation, segregation, and storage
- Identify the expected hazards, including concentrations of contaminants and levels of exposure
- Identify health and safety and personal protective equipment requirements on the basis of expected contaminants and concentrations
- Identify potential deviations to the expected conditions
- Define action levels for implementing plans to mitigate any increases in contaminant concentrations
- Outline incident response plans for implementing engineering controls
- Outline contingency plans to address emergency situations

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